

AIUM Practice Guideline for the Performance of Fetal Echocardiography



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The American Institute of Ultrasound in Medicine (AIUM) is a multidisciplinary association dedicated to advancing the safe and effective use of ultrasound in medicine through professional and public education, research, development of guidelines, and accreditation. To promote this mission, the AIUM is pleased to publish in conjunction with the American College of Obstetricians and Gynecologists (ACOG) and the Society for Maternal-Fetal Medicine (SMFM) this *AIUM Practice Guideline for the Performance of Fetal Echocardiography*. Additionally, this guideline is endorsed by the American College of Radiology (ACR).

The AIUM represents the entire range of clinical and basic science interests in medical diagnostic ultrasound, and, with hundreds of volunteers, this multidisciplinary organization has promoted the safe and effective use of ultrasound in clinical medicine for more than 50 years. This document and others like it will continue to advance this mission.

Practice guidelines of the AIUM are intended to provide the medical ultrasound community with guidelines for the performance and recording of high-quality ultrasound examinations. The guidelines reflect what the AIUM considers the minimum criteria for a complete examination in each area but are not intended to establish a legal standard of care. AIUM-accredited practices are expected to generally follow the guidelines with recognition that deviations from these guidelines will be needed in some cases, depending on patient needs and available equipment. Practices are encouraged to go beyond the guidelines to provide additional service and information as needed.

The clinical aspects contained in specific sections of this practice guideline (Introduction, Indications, Specifications of the Examination, and Equipment Specifications) were developed collaboratively by the American Institute of Ultrasound in Medicine (AIUM), American College of Radiology (ACR), American College of Obstetricians and Gynecologists (ACOG), and Society for Maternal-Fetal Medicine (SMFM). Recommendations for physician requirements, written request for the examination, documentation, and quality control vary among these organizations and are addressed by each separately.



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I. Introduction

Congenital heart disease is a leading cause of infant morbidity and mortality from birth defects, with an estimated incidence of 6 per 1000 live births for moderate to severe forms.^{1,2} Accurate prenatal diagnosis offers potential clinical benefit with regard to infant outcomes, especially in those cases that are likely to require prostaglandin infusion to maintain patency of the ductus arteriosus.³⁻⁵ Fetal echocardiography is broadly defined as a detailed sonographic evaluation that is used to identify and characterize fetal heart anomalies before delivery. This specialized diagnostic procedure is an extension of the “basic” and “extended basic” fetal cardiac screening guidelines that have been previously described for the 4-chamber view and outflow tracts.^{6,7} It should be performed only when there is a valid medical reason, and the lowest possible ultrasonic exposure settings should be used to gain the necessary diagnostic information. In some cases, additional or specialized examinations such as the inclusion of color Doppler sonography may be necessary. While it is not possible to detect every abnormality, adherence to the following guideline will maximize the probability of detecting most cases of clinically significant congenital heart disease.

II. Qualifications and Responsibilities of Personnel

See the AIUM Official Statement *Training Guidelines for Physicians Who Evaluate and Interpret Diagnostic Ultrasound Examinations* and the *AIUM Standards and Guidelines for the Accreditation of Ultrasound Practices*.

III. Indications

Indications for fetal echocardiography are often based on a variety of parental and fetal risk factors for congenital heart disease.^{8,9} However, most cases are not associated with known risk factors. Common indications for a detailed scan of the fetal heart include but are not limited to:

Maternal Indications

- Autoimmune antibodies, anti-Ro (SSA)/anti-La (SSB);
- Familial inherited disorders (eg, Marfan syndrome);
- First-degree relative with congenital heart disease;
- In vitro fertilization;
- Metabolic disease (eg, diabetes mellitus and phenylketonuria); and
- Teratogen exposure (eg, retinoids and lithium).

Fetal Indications

- Abnormal cardiac screening examination;
- Abnormal heart rate or rhythm;
- Fetal chromosomal anomaly;
- Extracardiac anomaly;
- Hydrops;
- Increased nuchal translucency;
- Monochorionic twins; and
- Unexplained severe polyhydramnios.

IV. Written Request for the Examination

The written or electronic request for an ultrasound examination should provide sufficient information to allow for the appropriate performance and interpretation of the examination.

A request for the examination must be originated by a physician or other appropriately licensed health care provider or under their direction. The accompanying clinical information should be provided by a physician or other appropriate health care provider familiar with the patient's clinical situation and should be consistent with relevant legal and local health care facility requirements.

V. Specifications of the Examination

The following section details recommended and optional elements for fetal echocardiography.

A. General Considerations

Fetal echocardiography is commonly performed between 18 and 22 weeks' gestational age. Some forms of congenital heart disease may even be recognized during earlier stages of pregnancy.¹⁰ Optimal views of the heart are usually obtained when the cardiac apex is directed toward the anterior or maternal wall. Technical limitations (eg, maternal obesity or prone fetal position) can make a detailed heart evaluation very difficult because of acoustic shadowing, especially during the third trimester. It may be necessary to examine the patient at a different time if the heart is poorly visualized. The examiner can optimize sonographic images by appropriate adjustment of technical settings, such as acoustic focus, frequency selection, signal gain, image magnification, temporal resolution, harmonic imaging, and Doppler-related parameters (eg, velocity scale, frequency wall filter, and frame rate).

B. Cardiac Imaging Parameters: Basic Approach

The fetal echocardiogram is a detailed evaluation of cardiac structure and function. This method typically involves a sequential segmental analysis of 3 basic areas that include the atria, ventricles, and great arteries and their connections.^{11–13} A segmental analysis includes an assessment of the following connections and their relationships:

- Atrial arrangement (situs);
- Atrioventricular junction between the atria and ventricles;
- Ventriculoarterial junction between the ventricle and arterial outflow tracts.

Each anatomic segment can be further evaluated for associated anomalies such as cardiac malposition, atrial isomerism, aortic override, an atrial septal defect, a ventricular septal defect, myocardial hypertrophy, abnormal systemic and pulmonary venous connections, a restricted foramen ovale mechanism, ventricular disproportion, coarctation, and abnormal development of mitral or tricuspid valves.

C. Gray Scale Imaging (Recommended)

Key scanning planes can provide useful diagnostic information about the fetal heart (Figures 1–3).^{14–19} The following cardiac images should be obtained:

- Four-chamber view;
- Left ventricular outflow tract;
- Right ventricular outflow tract;
- Three-vessel and trachea view;
- Short-axis views (“low” for ventricles and “high” for outflow tracts);
- Aortic arch;
- Ductal arch;
- Superior vena cava; and
- Inferior vena cava.

D. Doppler Sonography (Optional but Recommended for Suspected Cardiac Flow Abnormalities)

Spectral, continuous wave, color, and/or power Doppler sonography can be used to evaluate the following structures for potential flow or rhythm disturbances^{20–23}:

- Pulmonary veins;
- Foramen ovale;
- Atrioventricular valves;
- Atrial and ventricular septa;
- Aortic and pulmonary valves;
- Ductus arteriosus; and
- Aortic arch.

E. M-Mode Echocardiography (Optional but Recommended for Cardiac Rate or Rhythm Abnormalities)

M-mode echocardiography displays moving structures along a thin sampling line over time. The high temporal resolution makes it useful for the assessment of ventricular contractility. Cardiac rhythm disturbances can be characterized by establishing an atrial rate, ventricular rate, and their relationship to each other. Alternative approaches, based on pulsed wave or tissue Doppler sonography, have also been used for evaluating fetal heart dysrhythmias.²⁴

F. Cardiac Biometry (Optional but Can Be Considered in the Presence of Structural Anomalies)

Normal ranges for fetal cardiac measurements have been published as percentiles and *z* scores that are based on gestational age or fetal biometry. Individual measurements can be determined from M-mode or 2-dimensional images, and they include the following parameters^{22,25–31}:

- Aortic and pulmonary artery diameters at the level of the valve annulus;
- Aortic arch and isthmus diameter measurements;
- End-diastolic ventricular dimensions just inferior to the atrioventricular valve leaflets; and
- Thickness of the ventricular free walls and interventricular septum just inferior to the atrioventricular valves.
- Additional measurements may be taken if warranted, including:
- Systolic dimensions of the ventricles;
- Transverse dimensions of the atria; and
- Diameter of branch pulmonary arteries.

G. Complementary Imaging Strategies (Optional)

Other adjunctive imaging modalities, such as 3- and 4-dimensional sonography, have been used to evaluate anatomic defects and to quantify fetal hemodynamic parameters, such as cardiac output. Doppler sonography and speckle-tracking technologies have also been described for ventricular strain and myocardial performance index measurements.^{32–39}

VI. Reporting and Documentation

Adequate documentation is essential for high-quality patient care. There should be a permanent record of the fetal echocardiographic examination and its interpretation. Images of all appropriate areas, both normal and abnormal, should be recorded. Variations from normal size should be accompanied by measurements. Images should be labeled with the patient identification, facility identification, examination date, and side (right or left) of the anatomic site imaged. An official interpretation (final report) of the diagnostic findings should be included in the patient's medical record. Retention of the ultrasound examination should be consistent both with clinical needs and with relevant legal and local health care facility requirements. Reporting should be in accordance with the *AIUM Standard for Documentation of an Ultrasound Examination*.^{40–42}

VII. Equipment Specifications

A sonographic examination of the fetal heart should be conducted using a real-time scanner. Sector, curvilinear, and endovaginal transducers are used for this purpose. The transducer or scanner should be adjusted to operate at the highest clinically appropriate frequency, realizing that there is a trade-off between resolution and beam penetration. With modern equipment, fetal imaging studies performed from the anterior abdominal wall can usually use frequencies of 3.5 MHz or higher, while scans performed from the vagina should be performed using frequencies of 5 MHz or higher. Acoustic shadowing and maternal body habitus may limit the ability of higher-frequency transducers to provide greater anatomic detail for the fetal heart.

VIII. Quality Control and Improvement, Safety, Infection Control, and Patient Education

Policies and procedures related to quality control, patient education, infection control, and safety should be developed and implemented in accordance with the *AIUM Standards and Guidelines for the Accreditation of Ultrasound Practices*.

Equipment performance monitoring should be in accordance with the *AIUM Standards and Guidelines for the Accreditation of Ultrasound Practices*.

IX. ALARA Principle

The potential benefits and risks of each examination should be considered. The ALARA (as low as reasonably achievable) principle should be observed when adjusting controls that affect the acoustic output and by considering transducer dwell times. Further details on ALARA may be found in the AIUM publication *Medical Ultrasound Safety*.

Acknowledgments

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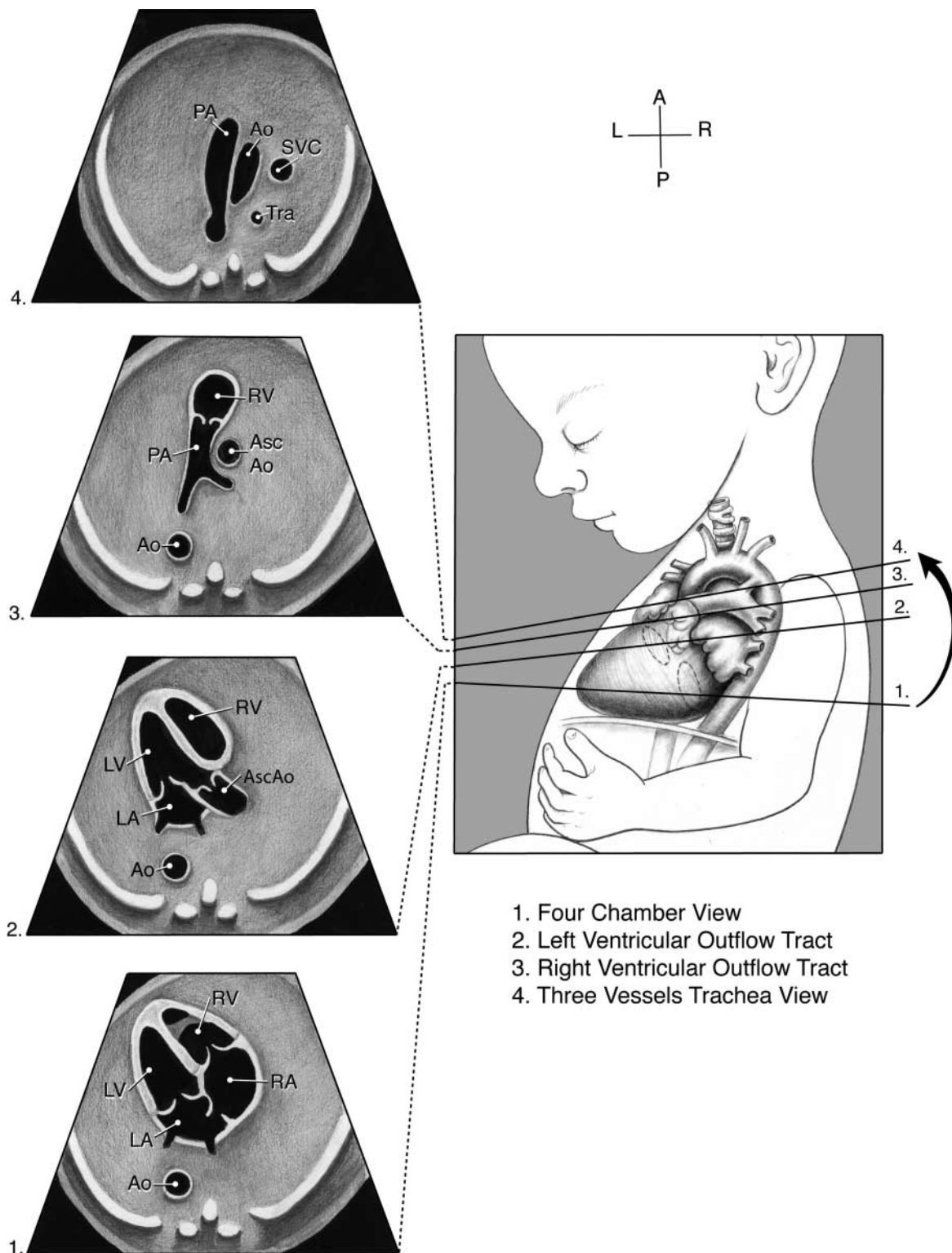


Figure 1. Standardized transverse scanning planes for fetal echocardiography include an evaluation of the 4-chamber view (1), arterial outflow tracts (2 and 3), and the 3-vessel and trachea view (4). Ao indicates descending aorta; Asc Ao, ascending aorta; LA, left atrium; LV, left ventricle; PA, pulmonary artery; RA, right atrium; RV, right ventricle; and Tra, trachea.

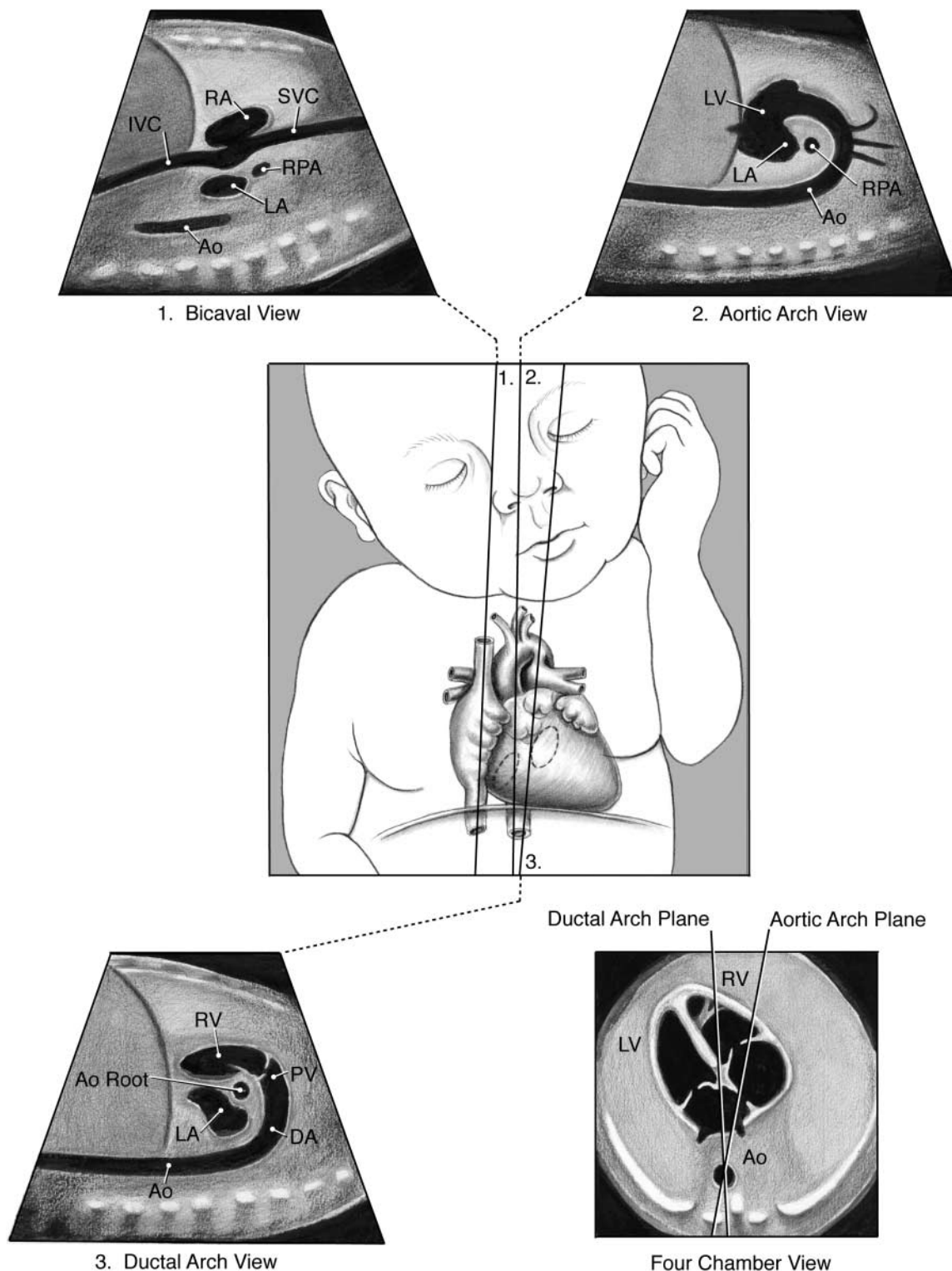
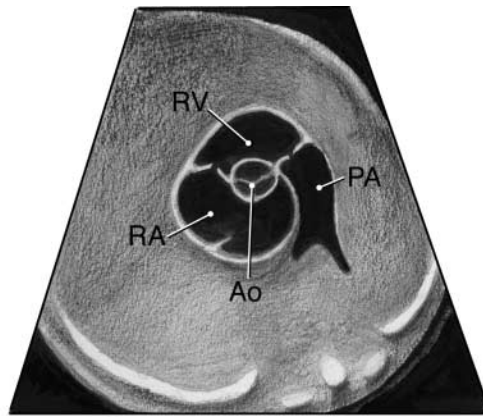
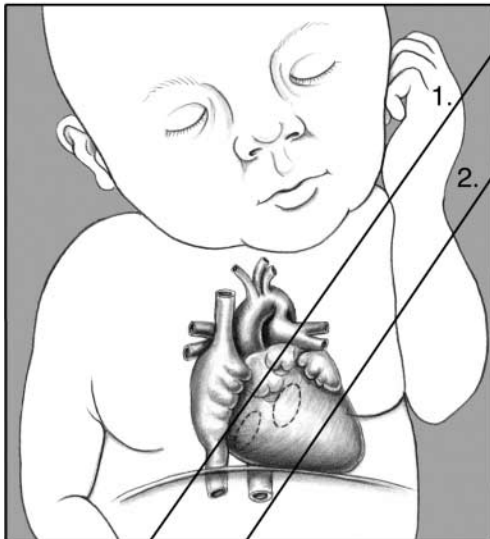


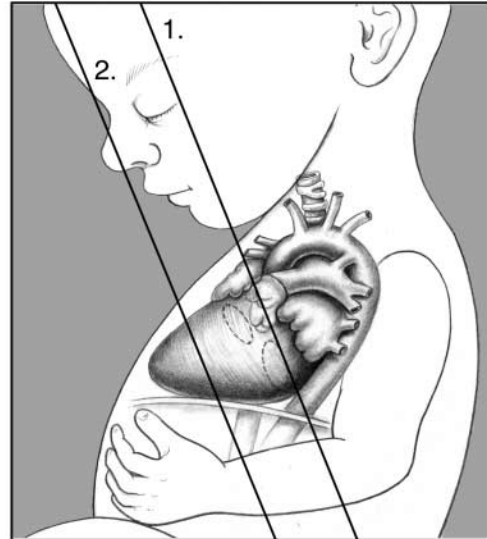
Figure 2. Sagittal views of the superior and inferior vena cava (1), aortic arch (2), and ductal arch (3). The scan angle between the ductal arch and thoracic aorta ranges between 10° and 19° during pregnancy, as illustrated by the 4-chamber view diagram (Espinoza J, Gotsch F, Kusanovic JP, et al. Changes in fetal cardiac geometry with gestation: implications for 3- and 4-dimensional fetal echocardiography. *J Ultrasound Med* 2007; 26:437–443). Ao or Desc Ao indicates descending aorta; Ao Root, aortic root; DA, ductus arteriosus; IVC, inferior vena cava; LA, left atrium; LV, left ventricle; PV, pulmonary valve; RA, right atrium; RPA, right pulmonary artery; RV, right ventricle; and SVC, superior vena cava.



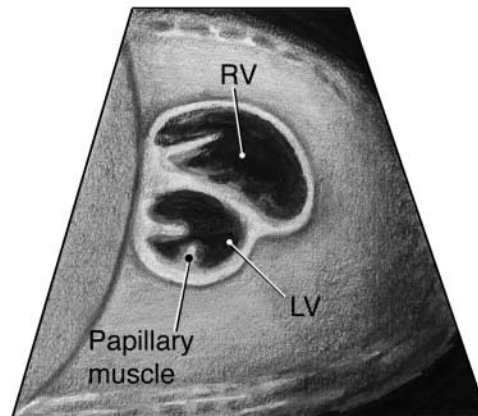
1. High Short Axis View - Great Arteries



Fetal Heart - Coronal View



Fetal Heart - Sagittal View



2. Low Short Axis View - Ventricles

Figure 3. Low and high short-axis views of the fetal heart. Ao indicates aortic valve; DA, ductus arteriosus; LV, left ventricle; PA, pulmonary artery; RA, right atrium; and RV, right ventricle.